

Cyanotoxins in Virginia Tidal Fresh Waters

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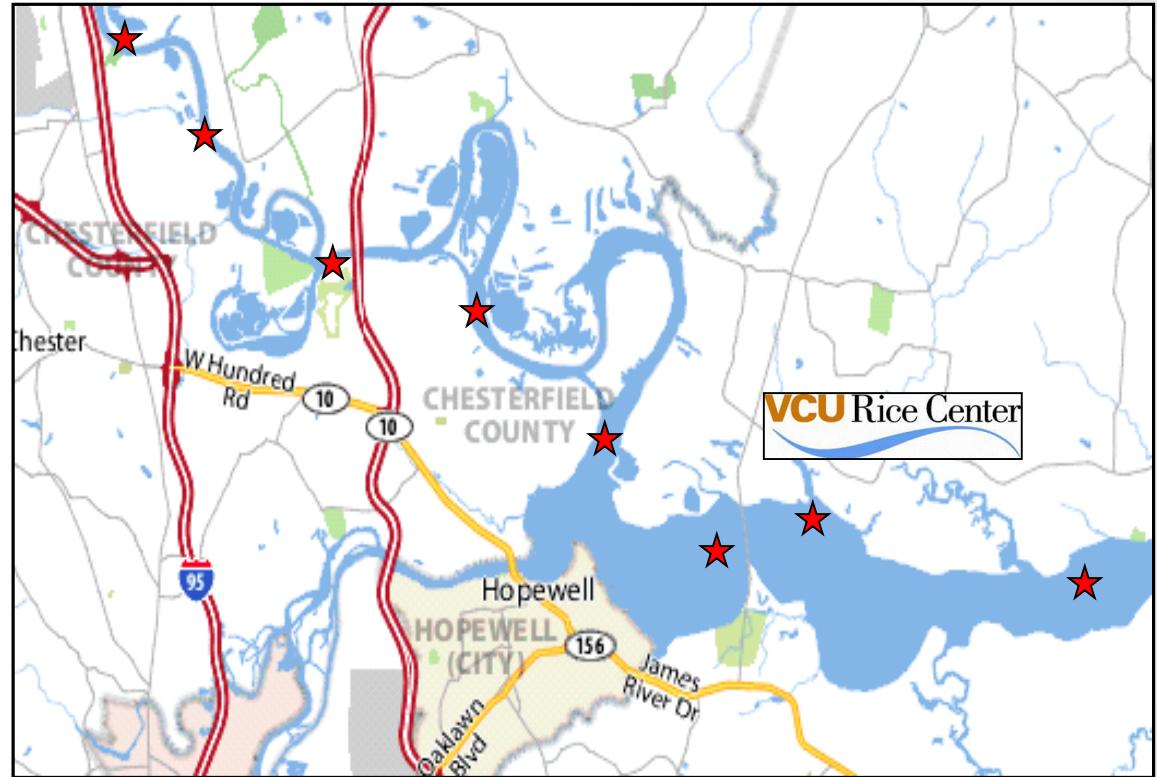
Center for Environmental Studies

Rice Rivers Center

Virginia Commonwealth University

James Monitoring Program

- 10 stations spanning tidal fresh segment.
- Nutrients, sediment, bacteria, Chlorophyll-a, cyanotoxins (mostly microcystin, some anatoxin).
- Weekly during May-October; bi-weekly during November-April.
- 10th year (2010-present).

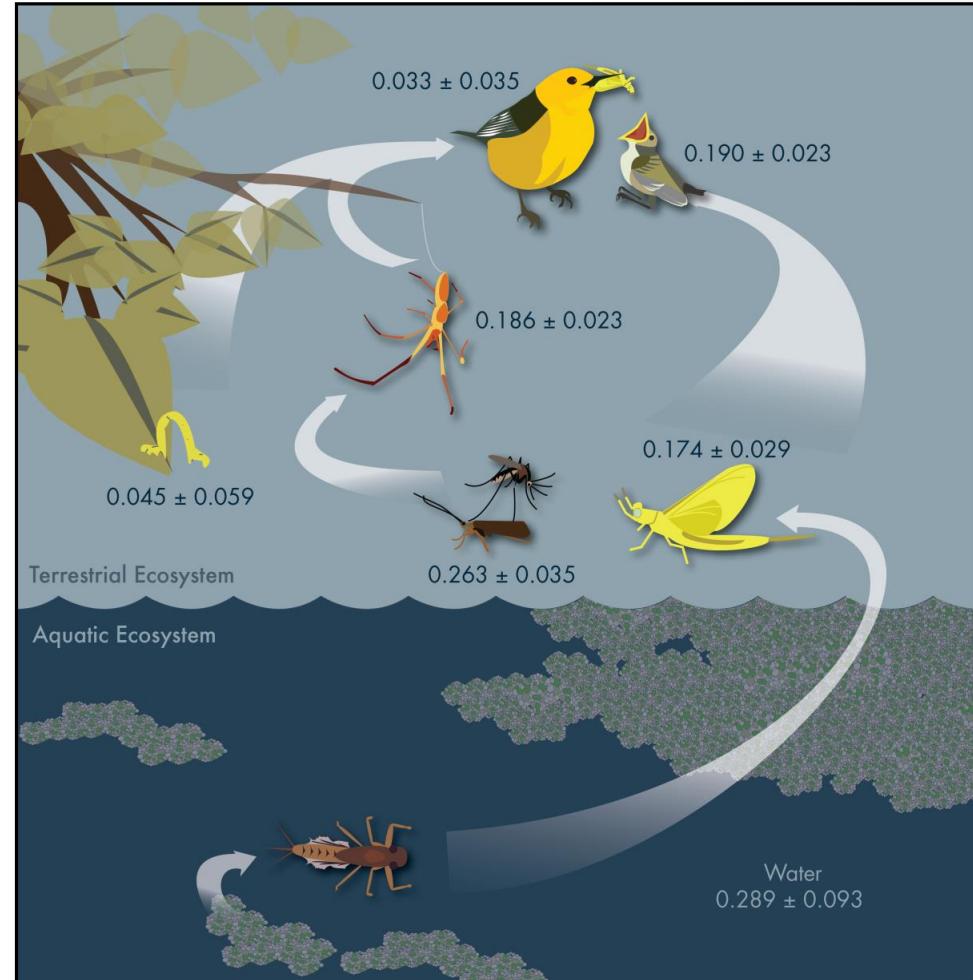


★ monitoring stations (2 off map in Richmond)

Special Studies

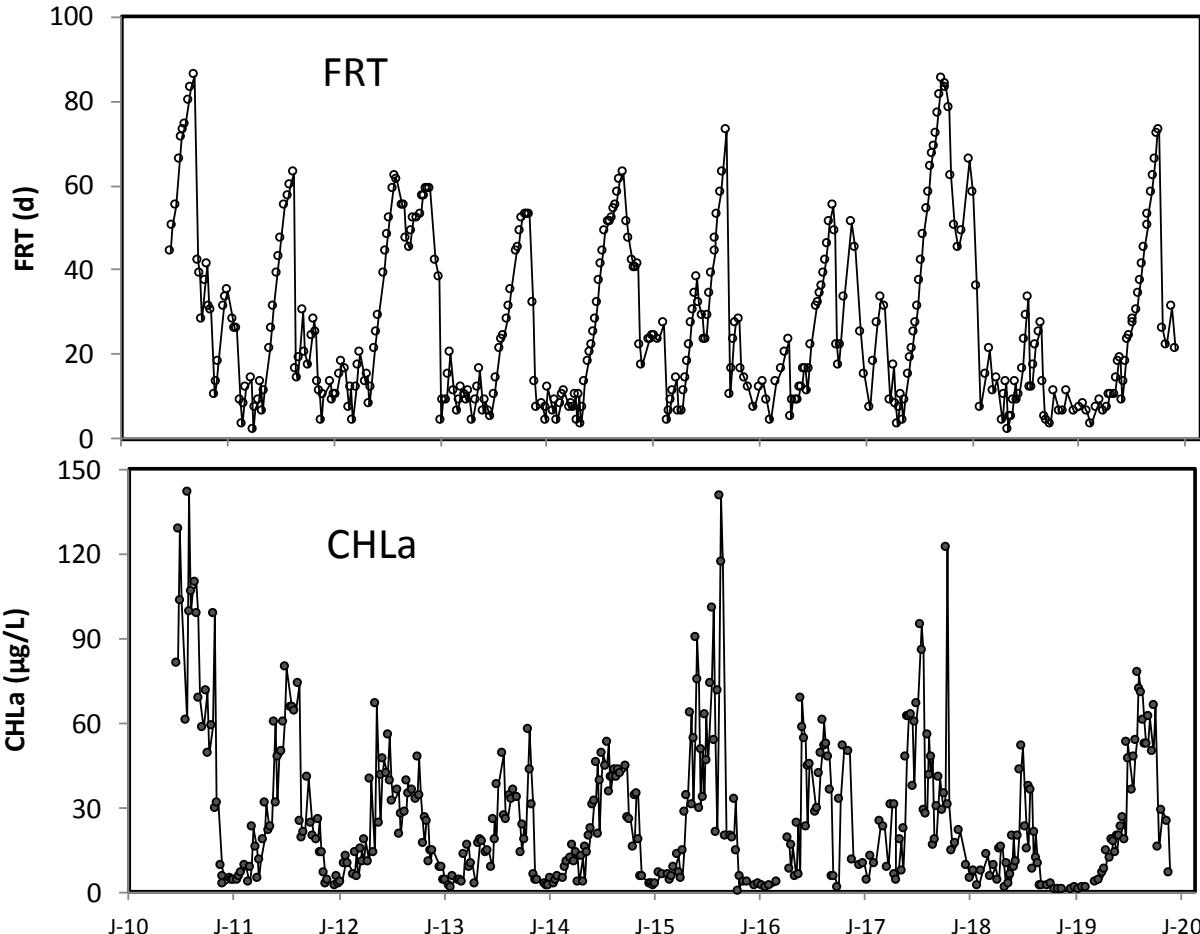
- Comparison of algal blooms in tidal freshwaters of James, Pamunkey and Mattaponi (2017-19).
- Mesocosm experiments to identify factors controlling cyanobacteria abundance and toxin production.
- Algal toxins in aquatic and riparian food webs.

Moy et al. (2016) *ES&T*.
Units are $\mu\text{g MC/g dm}$



Monitoring Results

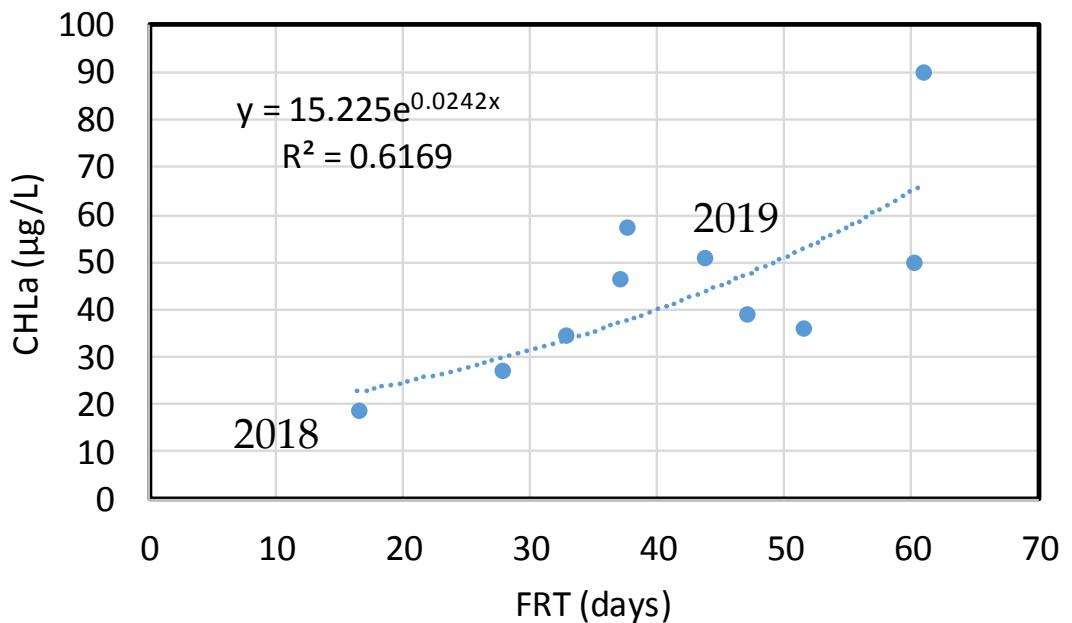
- Summer blooms a persistent feature of James lower tidal fresh segment.
- Severity and duration of blooms dependent on freshwater replacement time.



Bukaveckas et al. (2018) Harmful Algae (updated)

2018-2019

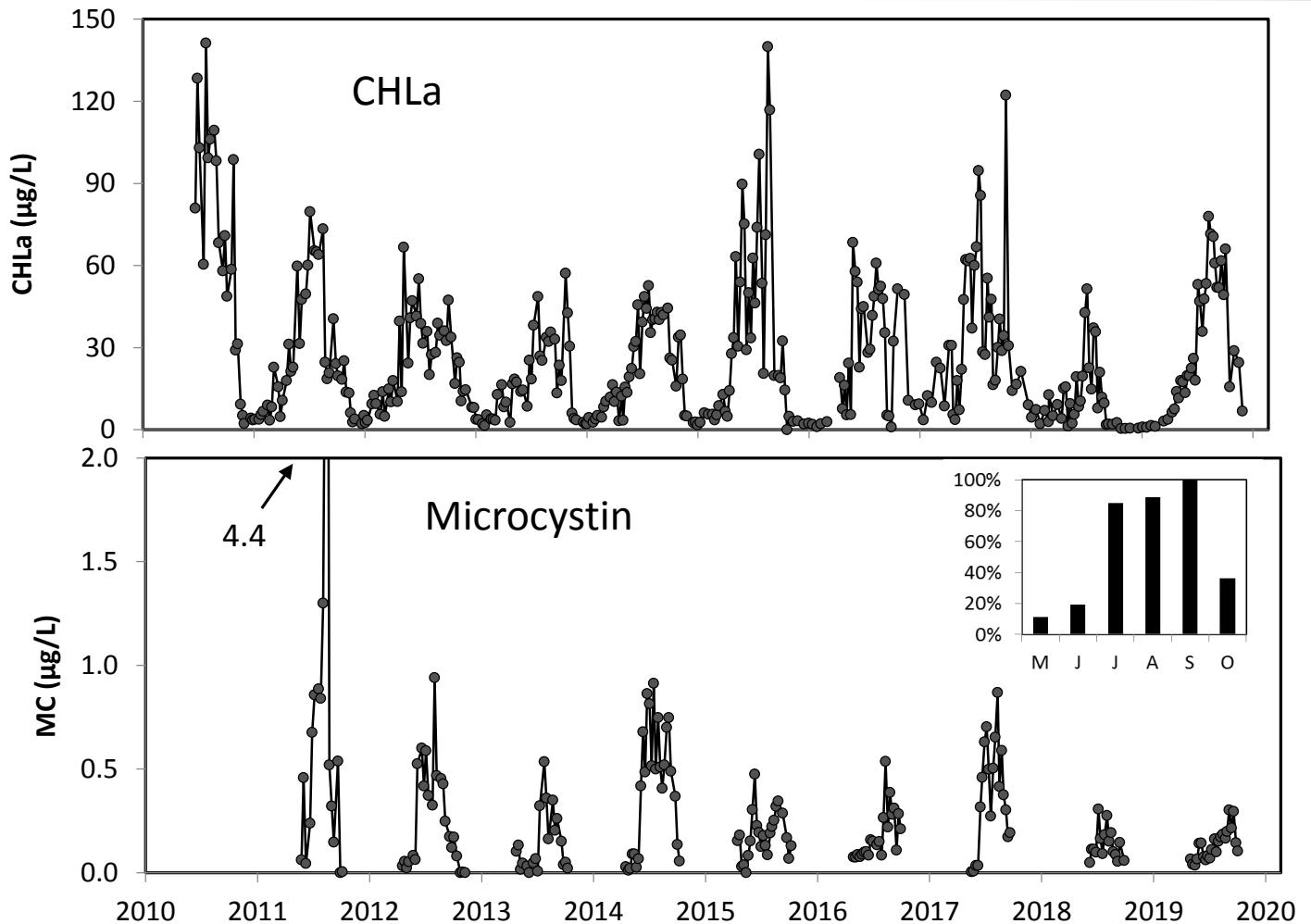
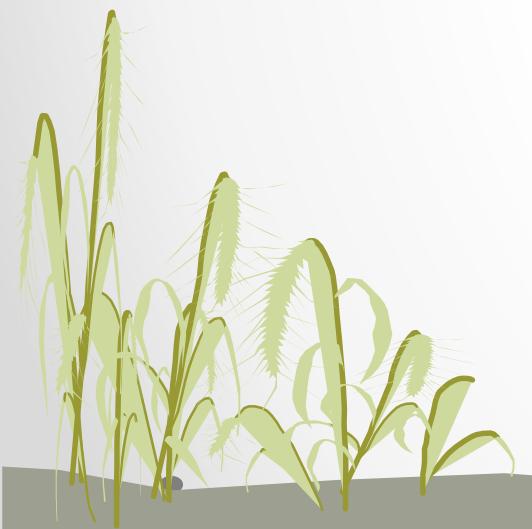
- 2018 (wet year): shortest FRT and lowest mean CHLa during 10-y span.
- 2019 (wet early, but dry conditions persist to late summer): 3rd longest recorded bloom over past 10 years.



Relationship between mean summer CHLa (Jul-Oct) and Freshwater Replacement Time.

Microcystin

- Microcystin measureable in >80% of water samples during July-Sept.
- Concentrations generally < 1.0 µg/L.



Comparison among Tidal Freshwaters

Year	Microcystin ($\mu\text{g/L}$) June-Oct Average									
	JMS 56 (LTF)	JMS 69 (LTF)	JMS 75 (LTF)	JMS 99 (UTF)	MPN38 (TF)	MPN29 (TF)	MPN4 (OH)	PMK55 (TF)	PMK39 (TF)	PMK6 (OH)
2011	nd	0.97	0.70	0.10						
2012	0.30	0.48	0.36	0.05						
2013	0.11	0.21	0.18	0.03						
2014	0.43	0.66	0.48	0.06						
2015	0.18	0.20	0.20	0.11						
2016	0.21	0.21	0.20	0.11						
2017	0.38	0.47	0.37	0.09						
2018	0.18	0.18	0.13	0.05						
2019	nd	nd	0.14	0.06						
Mean	0.26	0.42	0.31	0.07						
SE	0.04	0.10	0.06	0.01						
N	127	148	160	138						

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2017	0.38	0.47	0.37	0.09	0.03	0.02	0.01	0.03	0.09	0.01
2018	0.18	0.18	0.13	0.05	0.04	0.04	nd	0.07	0.07	nd
2019	nd	nd	0.14	0.06	nd	nd	0.01	nd	nd	0.03
Mean	0.26	0.42	0.31	0.07						
SE	0.04	0.10	0.06	0.01						
N	127	148	160	138						

Consistently low microcystin in Mattaponi and Pamunkey relative to James lower tidal fresh segment.

Anatoxins in Tidal Freshwaters

- Similar values for JMS UTF and LTF despite CHLa LTF >> UTF.
- Low values for MPN and PMK except single high value: Lee Marsh = 1.74 ug/L on July 25, 2019 (run in duplicate).

Year	Anatoxin ($\mu\text{g/L}$) June-Oct Average				
	JMS 75 (LTF)	JMS 99 (UTF)	MPN4 (OH)	PMK39 (TF)	PMK6 (OH)
2018	0.16	0.12	nd	0.09	nd
2019	0.12	0.14	0.12	0.11	0.35
N	17	12	9	5	9

Future Plans

- Pamunkey & Mattaponi 3-year study completed.
- James CHLa monitoring continues (2020-2024).
 - Microcystin at two sites (UTF & LTF)?
 - Anatoxin?
- Potential collaboration with GMU for Potomac microcystin monitoring.

